Practice Final

Intro to AI Show (Su 99)
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Note:

1. It is possible that some of the following questions will appear on the actual final; it is even possible that *many* of the following questions will appear on the actual exam. Therefore, it would be prudent to try in earnest to study each of the following questions carefully.
2. Always pick the best answer of those available.

Question 1. The expression

$$Result(a_3,(Result(a_2,(Result(a_1,s_0)))))$$

denotes

□ **a** an action

□ **b** a term in FOL

□ **c** a situation

□ **d** a and b

□ **e** b and c

Question 1a. Would the expression

```
G(Result(a3,(Result(a2,(Result(a1,s0))))))
```

be accepted as grammatically correct by OTTER?

□ **a** Yes

□ **b** No

Question 2. Suppose that $\forall x(G(x) \Rightarrow R(x))$ and $G(a)$ are in KB_{13}. In standard first-order logic

$$\mathrm{KB}_{13} \vdash \exists z R(z)$$

□ **a** True

□ **b** False

Question 3. Suppose that KB_7 is non-empty. In standard first-order logic

$$\mathrm{KB}_7 \vdash \exists x(R(x) \Rightarrow \forall y R(y))$$

□ **a** True

□ **b** False

Question 4. Suppose that $\exists x \forall y x = y$ is in KB_{22}. In standard first-order logic

$$\text{KB}_{22} \vdash \exists x a = x$$

☐ **a** True

☐ **b** False

Question 5. Consider the following Lisp function.

```
(defun s-t (n vector)
     (check-type n number)
     (check-type vector list)
     (mapcar #'(lambda (x) (* x n)) vector))
```

Which of the following could be a possible input/output pair from this function?

☐ **a** `(s-t 5 5), 25`

☐ **b** `(s-t 5 (1 2 3 4 5)), (5 10 15 20 25)`

☐ **c** `(s-t 5 '(1 2 3 4 5)), (5 10 15 20 25)`

☐ **d** `(s-t 5 '(1 2 3 4 5)), 15)`

☐ **e** none of the above

Question 6. Consider the following quote.

> Everyone knows that dragons don't exist. But while this simplistic formulation may satisfy the layman, it does not suffice for the scientific mind. ... The brilliant Cerebron, attacking the problem analytically, discovered three distinct kinds of dragon: the mythical, the chimerical, and the purely hypothetical. They were all, one might say, nonexistent, but each nonexisted in an entirely different way.
>
> –Stanislaw Lem

Which operator in FOL can be used to make distinctions between things that don't exist, like dragons, and things that do?

☐ **a** λ

☐ **b** $\exists!$

☐ **c** ι

☐ **d** b and c

☐ **e** none of the above

Question 7. Which of the following are reasons for introducing a quasi-logical form?

☐ **a** To make it easier to write simple compositional grammar rules.

☐ **b** To extend the expressiveness of the semantic representation language.

☐ **c** To be able to represent quantifier scoping ambiguities in a succinct form.

☐ **d** a and c

☐ **e** a b c

Question 8. In order to determine the meaning of natural language sentence on the scheme presented in your text, the λ operator is used (as e.g. in $\lambda x Loves(x,Mary))(John)$). Explain why in no more than two sentences.

Question 9. This question concerns a language we call $Buffalo^n$, which is very much like English except the only word in its lexicon is *buffalo*. Here are two sentences from the language:

- Buffalo buffalo buffalo Buffalo buffalo.
- Bufalo Buffalo buffalo buffalo buffalo Buffalo buffalo.

Here are two English sentence with corresponding syntactic structure:

- Dallas cattle bewilder Denver cattle.
- Chefs London critics admire cook French food.

Write a grammar for $Buffalo^n$. The lexical categories are adjective, noun, and (transitive) verb. There should be one grammar rule for sentence, one for verb phrase, and three rules for noun phrase: raw noun, adjective modifier, and reduced relative clause (i.e., a relative clause without the word 'that'). Your grammar should be written neatly in the space provided just below.

Question 10. Consider the following Common Lisp function.

```
(defun f ()
      (let (results)
           (dolist (person (get 'people 'list) results)
               (let ((age (get person 'age))
                   (dolist (friend (get person 'friends))
                     (when (> (get friend 'age) age) (pushnew person results)))))))
```

In three succinct sentences, characterize this function. (Use the space provided just below.)

Question 11. (Tricky) Suppose that KB_6 includes the information in the blocks world grid for "Catching Colonel West" (shown on our web site). (So the knowledge base in question contains all information presented by the visual information in the 8×8 grid, as well as formulas that can be **observed** from this grid.) Suppose that the following formula is added to this knowledge base.

$$\forall x(H(x) \Leftrightarrow \neg \mathit{Cube}(x))$$

Then

- $KB_6 \vdash \neg\exists x\exists y(\mathit{Tet}(x) \wedge \mathit{Likes}(x,y))$

□ **a** true

□ **b** false

Question 12. Which of the following first-order formulas could represent "Alma's grandmother loves all maternal grandparents," where "$L(x, y)$" stands for "x loves y."

□ **a** $\forall x\forall y\forall z((f_m(z) = y \wedge f_m(y) = x) \Rightarrow L(f_m(f_m(a)), x))$

□ **b** $\forall x((\forall y\forall z(f_m(z) = y \wedge f_m(y) = x)) \Rightarrow L(f_m(f_m(a)), x))$

□ **c** $\forall x((\exists y\exists z(f_m(z) = y \wedge f_m(y) = x)) \Leftarrow L(f_m(f_m(a)), x))$

□ **d** $\forall x((\exists y\exists z(f_m(z) = y \wedge f_m(y) = x)) \Rightarrow L(x, f_m(f_m(a))))$

□ **e** none of the above

Question 13. Of the two functions `mapcar` and `mapc`, which would be used if the objective of the Common Lisp programmer was to only cause certain side-effects?

□ **a** `mapcar`

□ **b** `mapc`

□ **c** either one; it doesn't matter

□ **d** actually `macroexpand` is the way to go

□ **e** none of the above

Question 14. Consider the following sentence in the propositional calculus. Complete the table that follows it, by writing down a 'Yes' or a 'No.'

$$\neg(P \Rightarrow (Q \Rightarrow P))$$

Concept	**Verdict** (Yes or No)
satisfiable	
valid	
well-formed	

Question 15. Consider the following first-order sentence. Complete the table that follows it, by writing down a 'Yes' or a 'No.'

$$\exists x(R(x) \Rightarrow \forall y R(y))$$

Concept	**Verdict** (Yes or No)
satisfiable	
valid	
well-formed	

Question 16. Recall the "Guessing Game." We shall say that a guessing rule is "winning" just in case the following is true. If you use the rule to choose your guesses, then no matter which set I have in mind, you are guaranteed to win in the limit. Specify a winning guessing rule for our game. (Write in the space provided just below.)

Question 17. Which of the following is the weight update rule used in back-propagation?

□ **a** $W_{j,i} \leftarrow + \alpha \times a_j \times Err_i \times g'(in_i)$

□ **b** $W_{j,i} \leftarrow + \alpha \times a_j \times \Delta_i$

□ **c** $W_j \leftarrow W_j + \alpha \times I_j \times Err$

□ **d** a and b

□ **e** a, b and c

Question 18. Construct by hand a neural network that computes the XOR function of two inputs. Make sure to specify what sort of units you are using. (Write your diagram in the space provided just below.)

Question 19. How many solutions are there to the 6-queens puzzle? Write the number here:

Question 20. Suppose that we abbreviate "Turing Machine (TM) m cannot ascertain whether or not TM m' halts after starting with input i" by $\neg A(m, m^i)$. Given this, and given that the list $m_0, m_1, \ldots$ is an enumeration of all TMs, which of the following sums up the halting problem?

□ **a** $\forall m_i \exists m_k \exists i \neg A(m_i, m_k^i)$

□ **b** $\exists m_i \forall m_k \exists i \neg A(m_i, m_k^i)$

□ **c** $\exists m_i \forall m_k \exists i \neg A(m_k, m_i^i)$

□ **d** $\forall m_i \forall m_k \exists i \neg A(m_i, m_k^i)$

□ **e** none of the above

Question 21. Which of the formulas in the set of possible answers for the previous question are true?

□ **a** a only

□ **b** a and b

□ **c** a, b and c

□ **d** a, b, c and d

□ **e** none of the above

Question 22. Fill in the missing values for the clause C_2 in the following set of clauses, given that C is the resolvent of C_1 and C_2. (Write your answer in the space provided.)

- $C = True \Rightarrow P(A, B)$
- $C_1 = P(x, y) \Rightarrow Q(x, y)$
- $C_2 =$

Question 23. Is the following inference — line 3 from lines 1 and 2 — valid?

1	$\forall x, y, n, l(((N(x, n) \wedge N(y, n) \wedge L(y, l)) \Rightarrow L(y, l))$	•
2	$N(f, b) \wedge L(f, p)$	•
3	$\forall x(N(x, b) \Rightarrow L(x, p))$	?

□ **a** Yes

□ **b** No

Question 24. Behavior-based robotics is an approach that would seem to have trouble giving robots the capability to

□ **a** avoid obstacles

□ **b** do proprioception

□ **c** fetch the cup from room it was in yesterday

□ **d** avoid expensive explicit deliberation

□ **e** none of the above

Question 25. Which of the following are reasons for building robots?

□ **a** augmenting human physical abilities

□ **b** giving humans telepresence

□ **c** dealing with hazardous environments

□ **d** automating "gofer" tasks

□ **e** all of the above

Question 26. Consider the following CL code.

```
(defun generates-sequencep (exp sequence)
    (let ((fn (make-fn exp)))
        (dotimes (n (length sequence) t)
            (unless (eql (funcall fn n) (elt sequence n))
                (return nil)))))
```

Of the agents you have heard discussed in this class, which is most likely to be based in part on this code? Answer:

Question 27. Match the following sets of equations (on left) with the learning techniques on the right by drawing a line from one to the other.

$B \wedge H \wedge D \models C$	RBL
$H \wedge D \models C$ $B \wedge D \models H$	EBL
$H \wedge D \models C$ $B \models H$	KBIL via ILP

Question 28. The following table specifies a certain Boolean function (with 3 inputs).

T	T	T	T
T	T	F	T
T	F	T	T
T	F	F	F
F	T	T	T
F	T	F	F
F	F	T	F
F	F	F	F

The name of this function is:
A formula from the propositional calculus (using three propositional variables and the connectives $\neg$ and $\wedge$) that represents this function is:

Question 29. Here are the three laws of robotics from the science fiction book *I, Robot* by Asimov:

1. A robot may not injure a human being or through inaction allow a human being to come to harm.
2. A robot must obey the orders given to it by human beings except where such orders would conflict with the first law.
3. A robot must protect its own existence as long as such protection does not conflict with the first or second law.

Are these laws sensible in your opinion? Can you think of a better set of laws? Answer these questions in a succinct essay of about four paragraphs.

Question 30. Consider the set of examples shown in Exercise 19.4 in your textbook. Design, on paper, both a perceptron and a feed-forward neural net that represent this function. You are encouraged to make the neural net a "logical net," that is, each node can compute either AND, OR, or NOT.

Question 31. Was Ralph stumped by the Liar Paradox? How about Junior?

□ **a** No; Yes

□ **b** Yes; No

□ **c** Yes; Yes

□ **d** No; No

□ **e** none of the above